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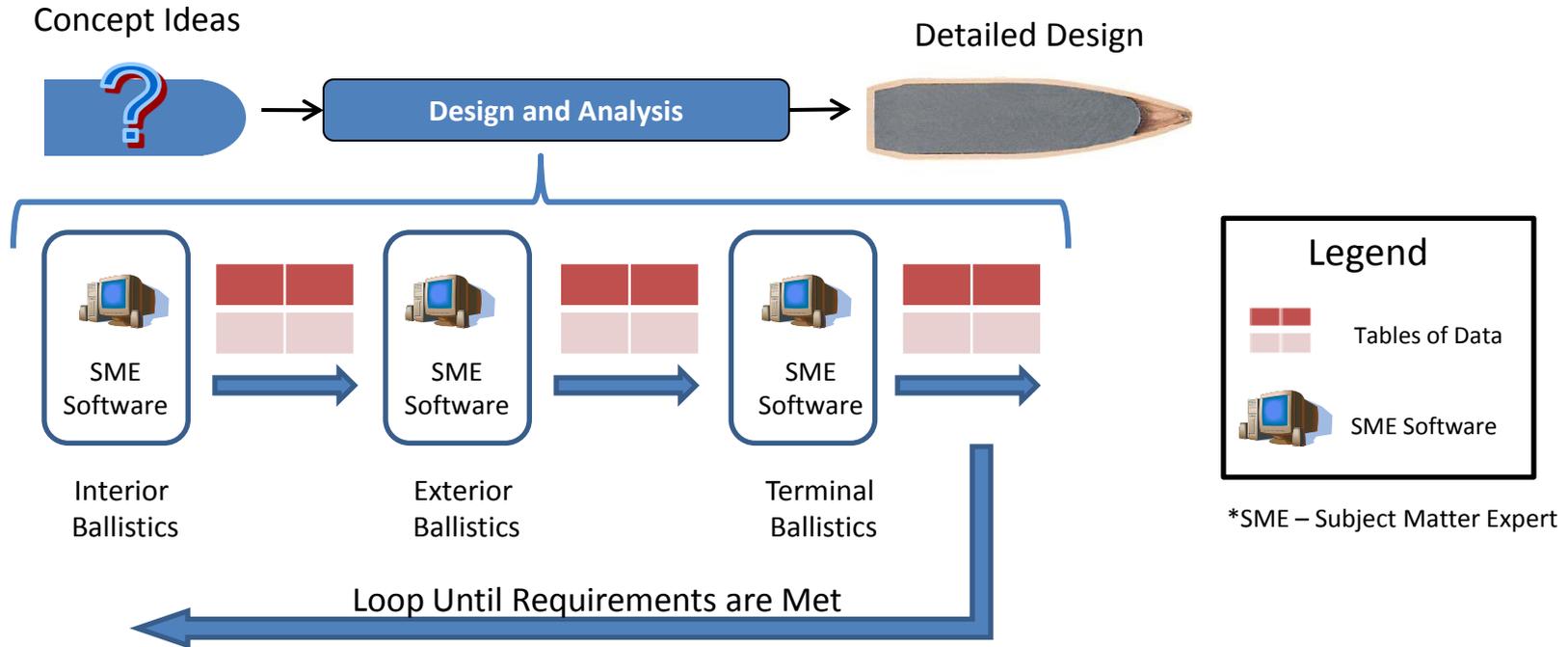
System Analysis with Integrated Modeling and Optimization
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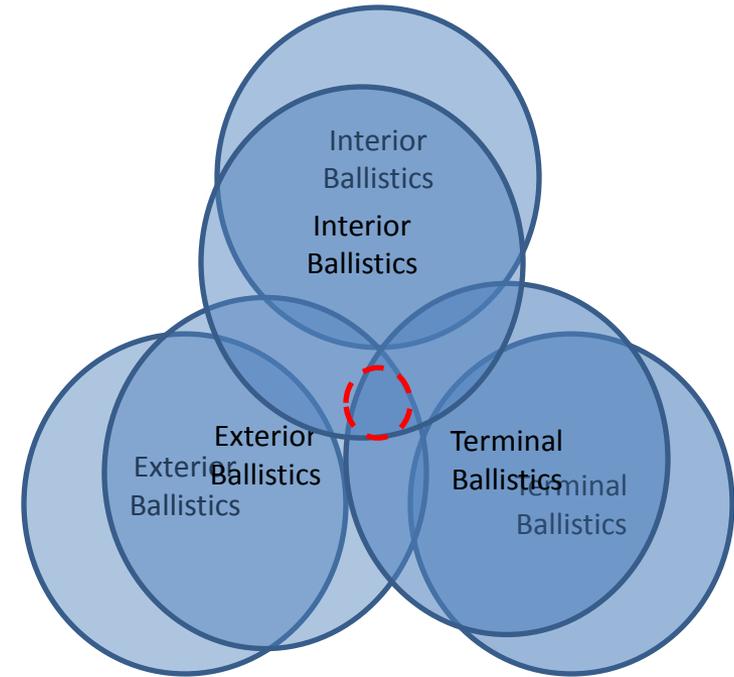
- Integrated System Modeling for Munitions
- Integrated Modeling and Optimization (IMO) Software
- Extended Area Protection and Survivability Example
- Questions

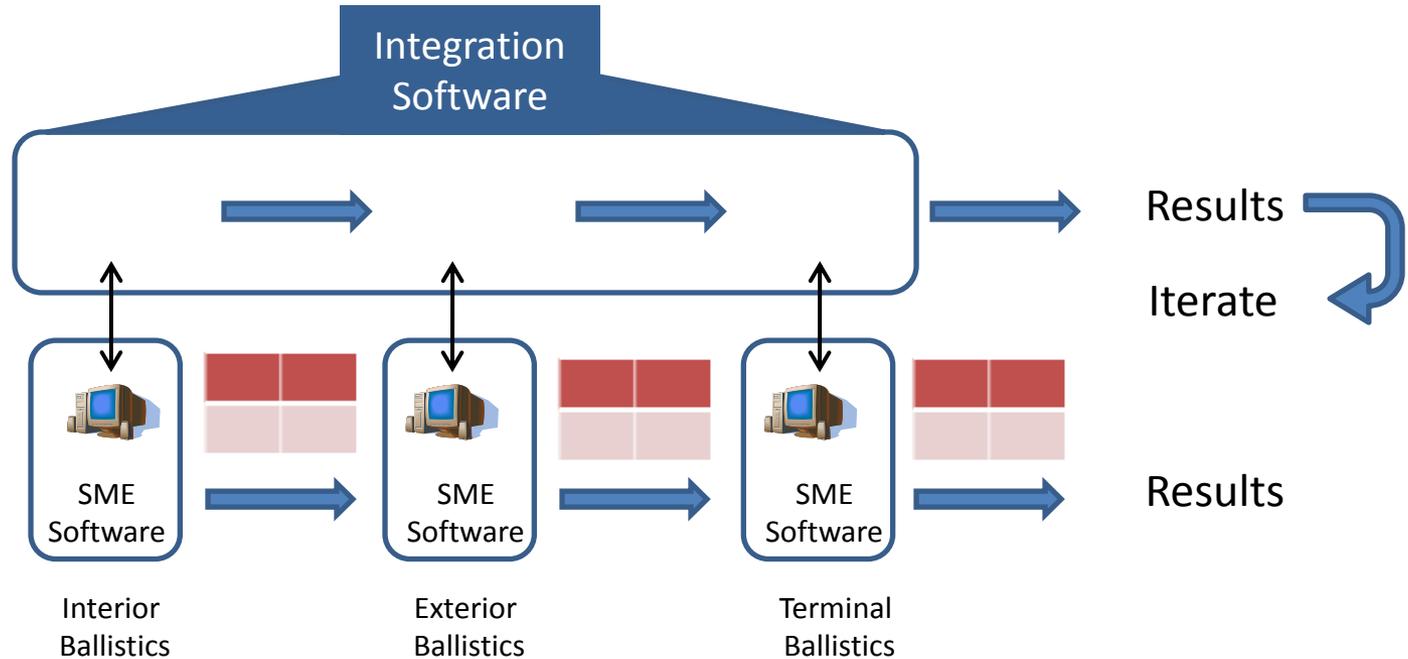


- Goal – Develop a design that meets or exceeds the requirements.
- Questions :
 - Is there enough time to perform sufficient design iterations?
 - Are the design dependencies well understood and quantified?
 - Is the sum of the parts the best for the system?



- New munitions seek more lethality in a lighter weight system
 - Multipurpose munitions.
 - Overdesigning is not an option.
- Overall system performance dependent on compromises between subsystems.
 - Systems or integration engineer tasked with this challenge.
- Using an integrated approach helps to find more common ground.
 - Quantitative rather than qualitative data for decisions.
- Establish working baseline for more detailed analysis.
 - Start with best design possible.

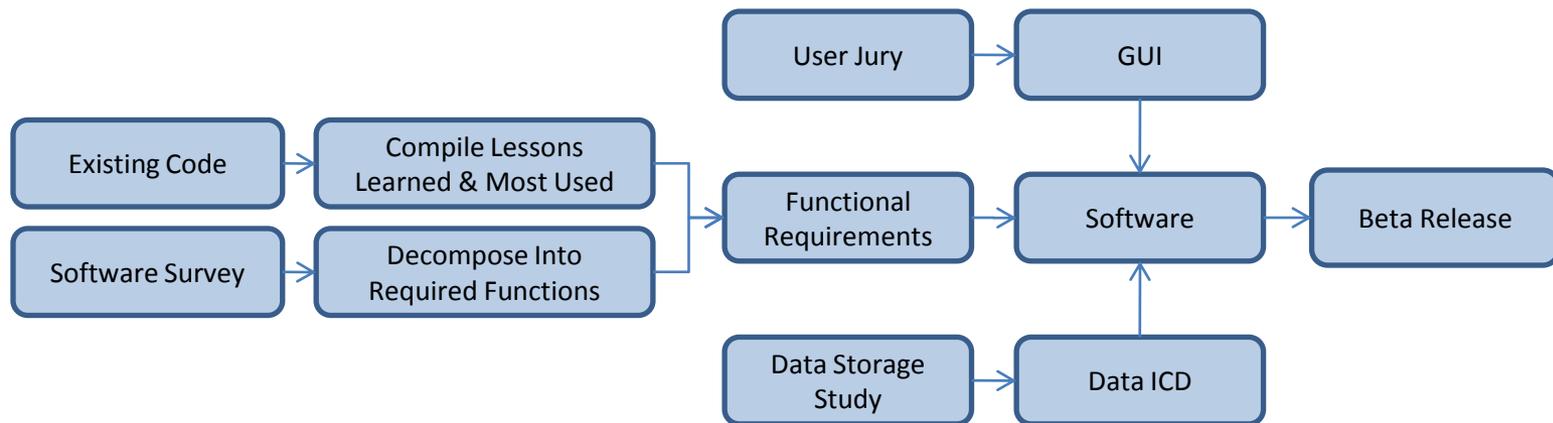




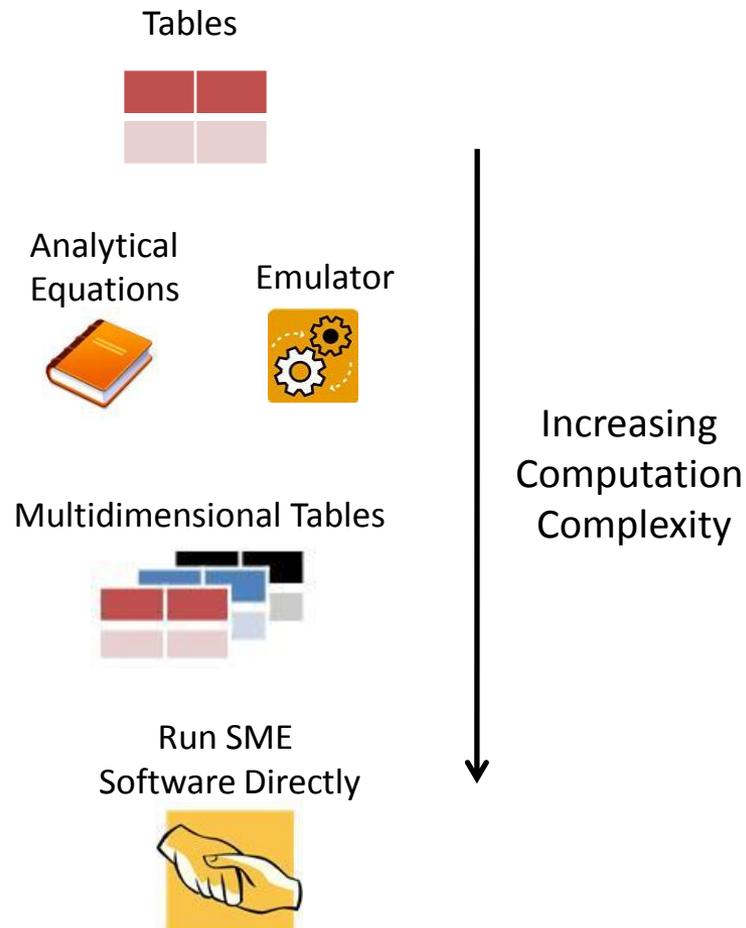
- An integrated workflow increases efficiency and permits more design evaluations than could be done before.
 - Increase the understanding of the design concepts via increased data availability.
- Well defined requirements lead to good designs.
 - Translation of performance requirements into design features with supporting qualitative data.



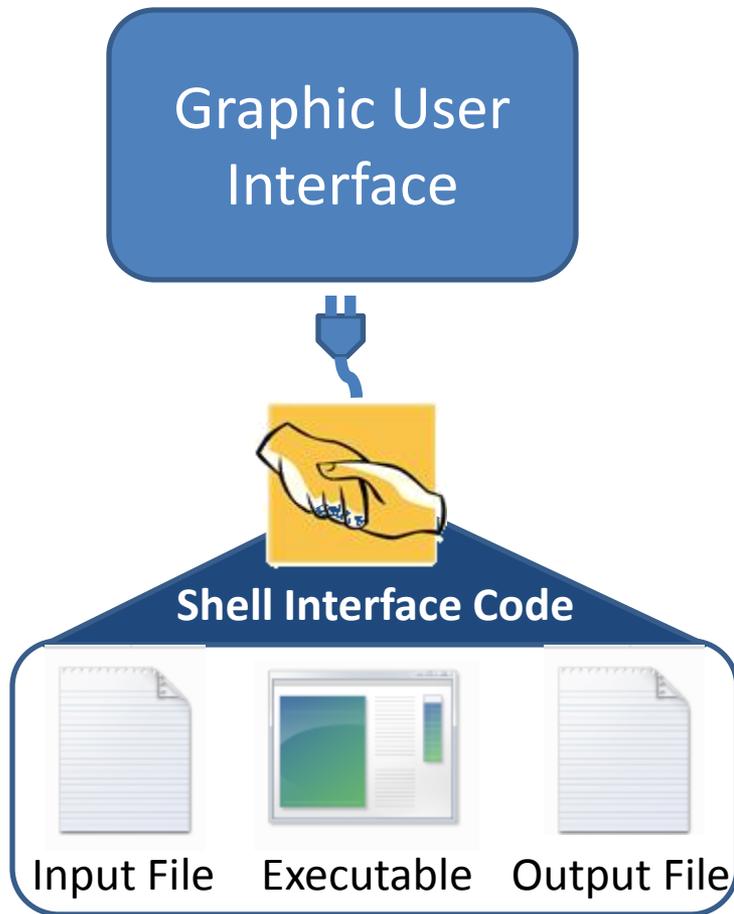
- Integrated Modeling and Optimization (IMO)
 - ARDEC software development project in 2011
- Mission Statement :
 - Increase the ARDEC wide integrated modeling capability through the development of software tools and by expanding SME use of the process via ATO support.
- IMO IPT is a subset of the ARDEC competencies.
 - Performed survey to identify software codes in use and workflow examples.



- Empirical data or manually created databases
 - A few variables, medium to low fidelity, low run time.
- Analytical Equations or “Emulator”
 - Medium fidelity, medium to low run time
 - Simplified model or equations to capture physics.
- Multidimensional Tables
 - Medium fidelity with fast run time
 - Multivariable relationships
 - Potential for reduced accuracy depending on system
- Build “shell” around existing software.
 - High fidelity and potentially higher run time
 - Complex multivariable analysis
 - ProEngineer, CTH, Abacus, Excel, Custom Executables, etc.

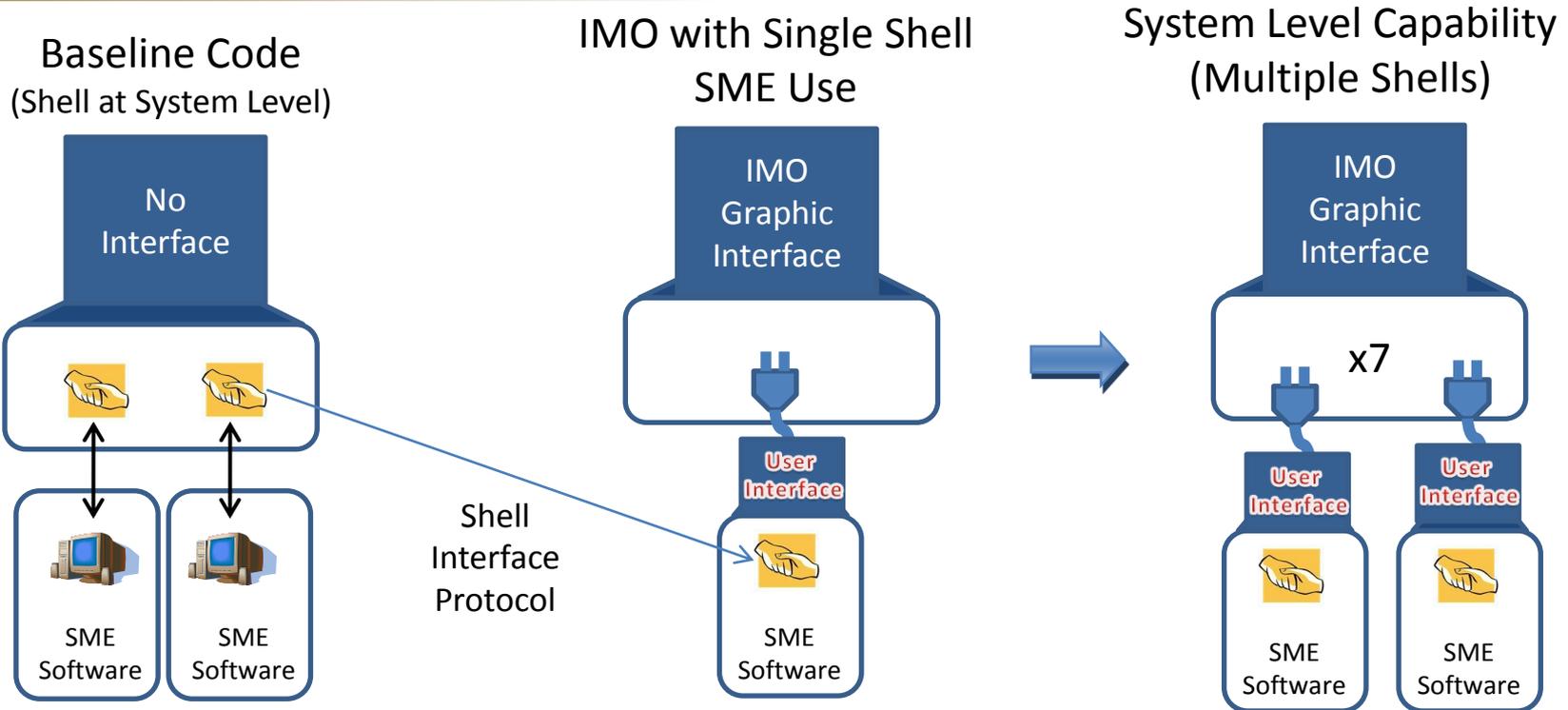


Selection of Form Factor Based on **Scope** of Analysis and **Time**

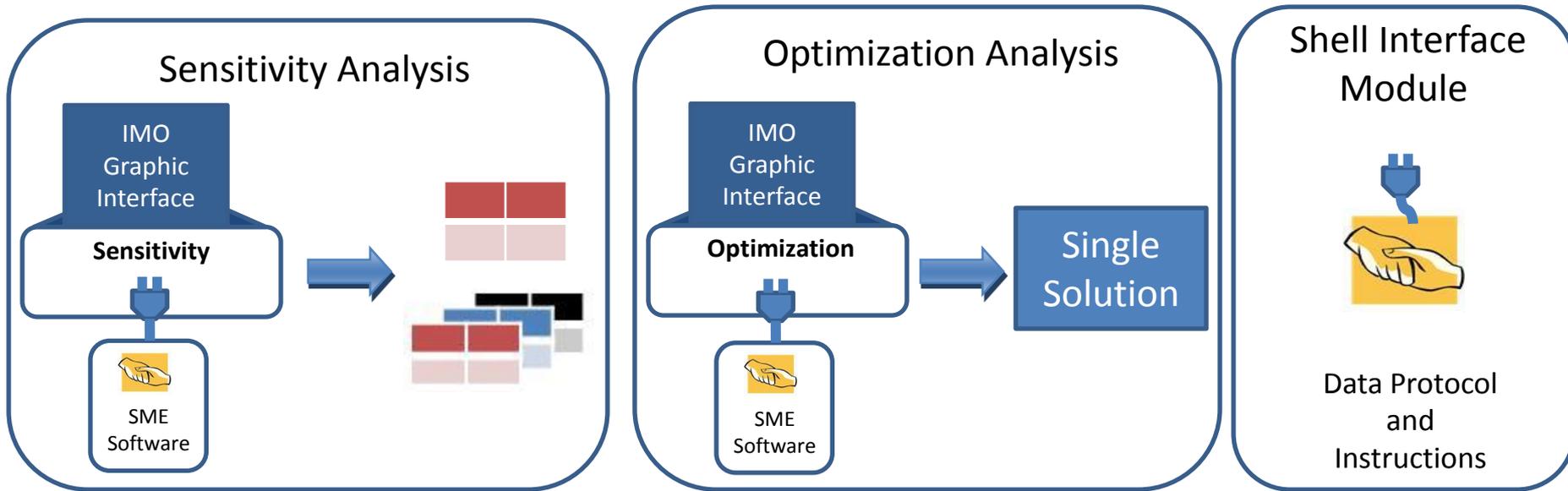


Generic Example

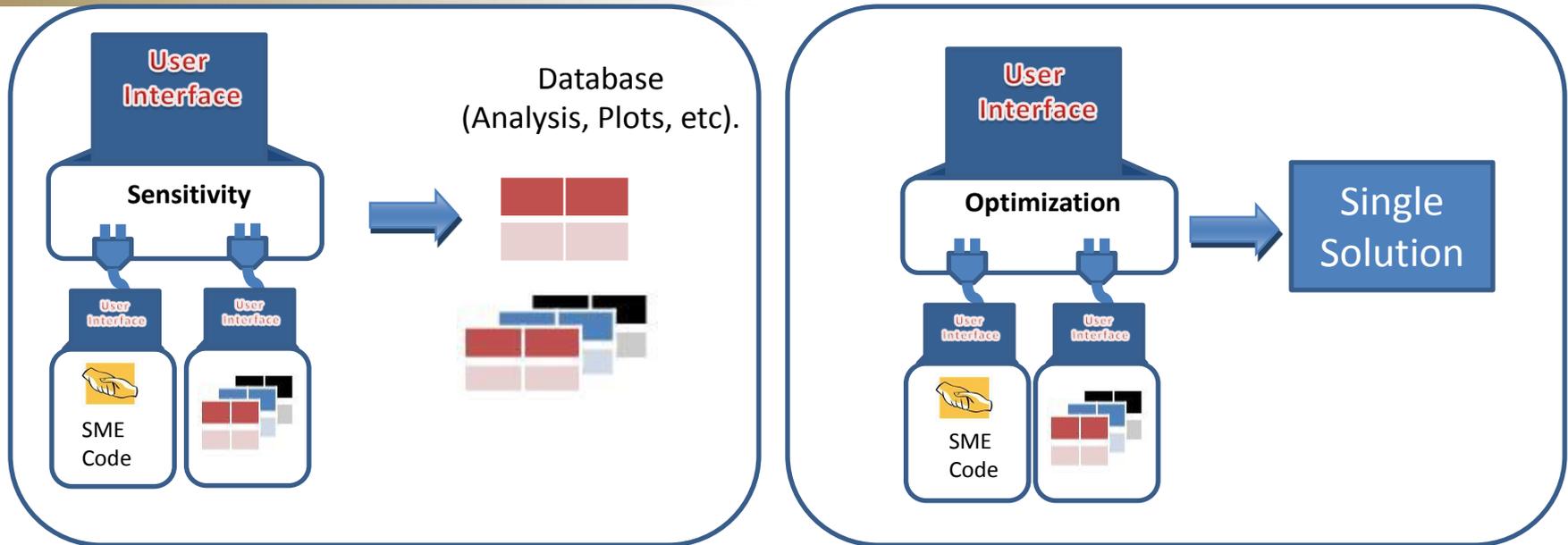
- A software “shell” is a set of execution instructions and data protocols to operate the software of interest via a third party software.
- IMO Analysis Software :
 - Run shells
 - Manage data
 - Run studies : optimization, Monte Carlo, etc.
 - Post processing
- IMO Graphic User Interface Aids SME in
 - Creating shell
 - Managing desired inputs / outputs.
 - Running single shell studies
- **SME takes ownership of shell.**



- Integration protocol transitioning from the system level to the SME level.
 - Provides the ability to “plug in” to larger system level analysis.
- Puts parametric and trade study code in the hands of modelers.
 - Allows for greater SME involvement, capability, and level of verification and validation.

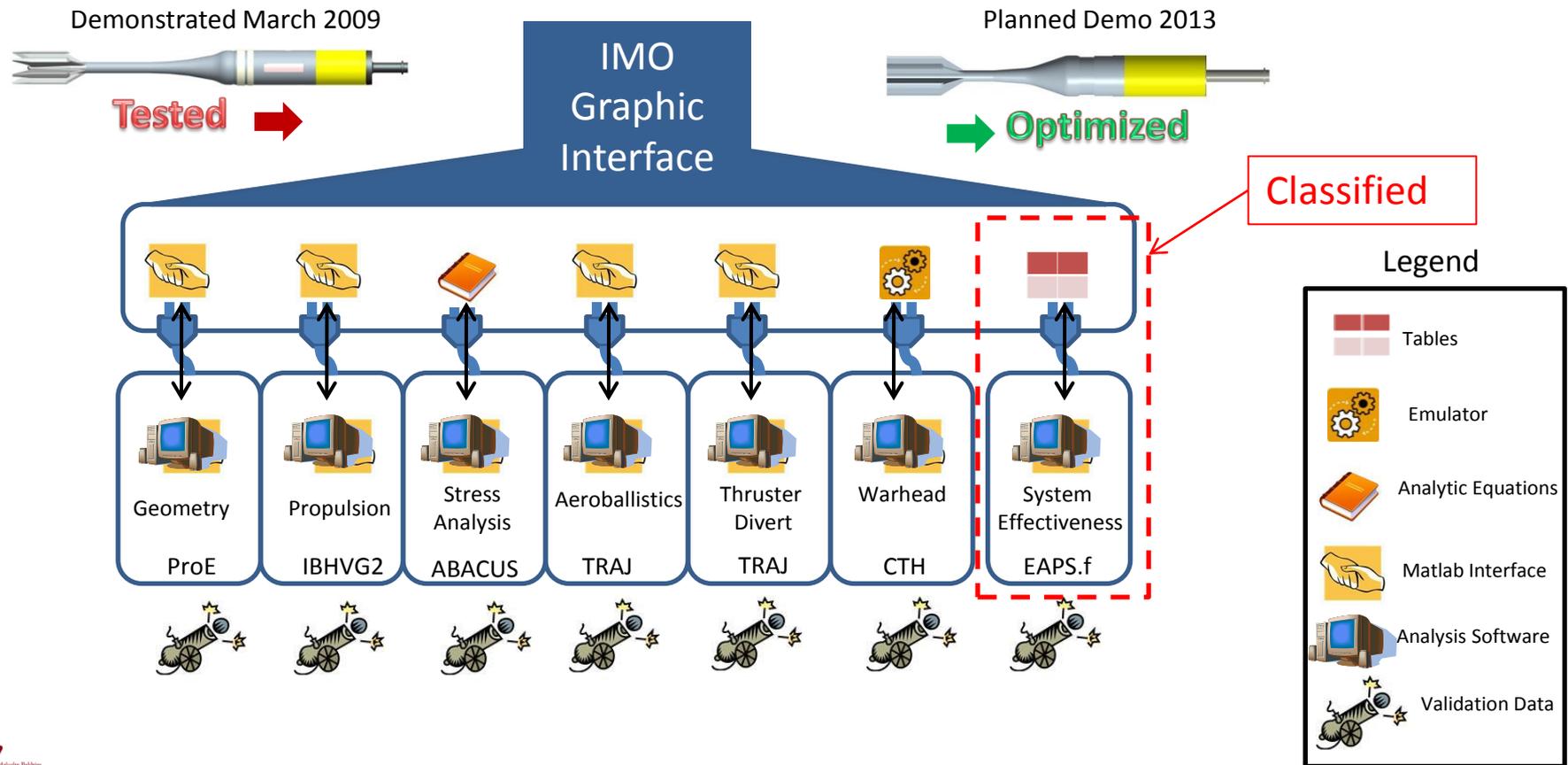


- Sensitivity
 - Generate databases, analyze, mine data, plots, etc.
- Optimization Analysis
 - Perform simple goal seek or more advance nonlinear discontinuous optimization.
- Shell Interface Module
 - Export shell for other SME users



- System level users work with the same software as the SME level user.
 - Multiple shells can be fed into IMO software for system analysis.
 - Type of shell can vary from databases to “plug in” shell modules.
 - IMO shells developed by the SME engineers to ensure a verified / validated implementation.
- Sensitivity & Optimization Analysis
 - Perform the same functions available to the SME user but at a more complex level.
 - Quantity cross functional design tradeoffs.

- 50mm ground to air defense projectile in technology demonstration phase.
- IMO used extensively to perform design refinements and numerous studies since 2006.





- An integrated modeling approach has proved very successful from multiple programs.
 - The M1040 was type classified in 2006 and had two related patents for the design concept and software.
 - The EAPS design has been influenced by numerous studies using integrated modeling.
- System modeling and optimization is not a new concept, but it's success is heavily tied to pairing the right tools to the organizational structure.
- The IMO software under development is tailored to ARDEC's specific needs and design practices.



Questions

